

FURTHER OBSERVATIONS ON THE CHEMICAL
COMPOSITION OF WOODS HOLE SEA
WATER—THE CHLORINE
CONTENT AND SALT
ANALYSIS.

IRVINE H. PAGE,

ELI LILLY RESEARCH LABORATORY, MARINE BIOLOGICAL LABORATORY, WOODS
HOLE, MASS.

From time to time we have had occasion to make further observations on the sea water at Woods Hole since the publication of the original analysis (1). Though not in any sense complete it is believed that the following data may prove useful and therefore they are presented.

It should be pointed out that our aim has been always to select methods of analysis which would adapt themselves to the use of relatively small fluid volumes, as only in this way can they become applicable to the investigation of physiological and biological problems. From the large number of analyses of sea water tabulated by the Hydrographic Laboratory of Copenhagen, Knudsen, Dittmar (2) etc., further data of this kind have oceanographic interest but little more. There has, therefore, been made a conscious attempt to utilize more sensitive methods which require small samples for analysis, albeit the absolute values *may* not be quite as accurate.

DETERMINATION OF CHLORINE.

Since many physiological activities are sensitive to slight changes in the tonicity of the surrounding medium it seemed of interest to determine whether the chlorine content of the Woods Hole sea water varied to a significant degree from day to day. The method employed was as follows: Standard AgNO_3 was made such that 1 cc. was equivalent to 10 mg. chlorine. This was standardized against pure NaCl since it has been shown by Thompson (3) that this salt may be substituted for standard water from the Hydrographic Laboratory. The AgNO_3 was

kept in the dark in a glass stoppered brown bottle and the standardization repeated at the end of the series of determinations. The method, thereafter, followed in detail that presented by the Association of Official Agricultural Chemists (4). The burette used was of 50 cc. capacity, standardized by the Bureau of Standards, Washington. 15 cc. samples of sea water were measured with a standardized pipette and diluted with distilled water to 35 cc. before titration.

Samples were taken from the laboratory tank. This tank is fed by water taken about 125 feet from shore. The other samples were taken from surface water as follows: (1) Buzzards Bay one half mile North of Robinson's Hole. (2) Cuttyhunk 300 feet from shore on the "Sound" side. (3) Tarpaulin cove one half mile out in the Sound; water 80 feet deep. (4) East of Nobska; water 28 feet deep.

Duplicate titrations were made and it may be said that these determinations but rarely disagreed.

The temperature was taken with not great accuracy, employing a standard 50 degree laboratory thermometer. Such slight changes as observed during these observations were not considered significant.

Grams of chlorine per kilogram were calculated from Thompson's empirical formula—

$$Cl_w = 0.008 + 0.99980 Cl_v - 0.001228 Cl_v^2$$

where Cl_w = grams of Cl per kilogram and Cl_v = grams Cl per liter at 20° C. A graph prepared by using the more common range of Cl contents was found useful.

The salinity—defined as the weight in grams of all the salts dissolved in a kilogram of sea water, after the carbonates have been converted to oxides, the Br and I have been replaced by Cl and the organic matter has been completely oxidized—was calculated from the relation derived by Knudson—

$$So/00 = 0.030 + 1.8050 Cl_w$$

Of course it must be recognized that this is only an approximation, as Giral (5) has emphasized.

During these observations it should be stated that the weather was in general extremely bad, rain alternating with fog for dis-

TABLE I.

CHLORINE CONTENT OF WOODS HOLE SEA WATER DURING THE SUMMER OF 1928.

Date.	Source.	Temperature.	Grams Cl per Liter.	Grams Cl per Kilogram.	So 'oo.
July 16...	Laboratory tank	21 degrees	17.80	17.42	31.47
" 18...	" "	22 "	17.80	17.42	31.47
" 21...	" "	21 "	17.86	17.48	31.58
" 23...	" "	21 "	17.77	17.39	31.42
" 26...	" "	21.8 "	17.77	17.39	31.42
" 28...	" "	21 "	17.86	17.48	31.58
August 1	" "	20.5 "	17.80	17.42	31.47
July 17...	Buzzards Bay...	20 "	17.93	17.54	31.69
" 17...	Cuttyhunk	20 "	18.00	17.60	31.79
" 21...	Off Tarpaulin Cove	20 "	17.93	17.54	31.69
" 21...	East Nobska	20 "	17.70	17.32	31.27

agreeably long intervals. The results, do not show any very marked changes in the Cl content of the water but it is altogether possible that a dry summer may increase the Cl content. Samples taken from other points along the uneven coast of Woods Hole show more evident variations, as was to be expected.

SEA SALT ANALYSIS.

Samples of the dried sea salt taken from the laboratory tank during the summer of 1926 have been analysed, employing the classical methods as given in the Bulletin of the Official Agricultural Chemists (4) and by Scott (6). Though not complete, these data are presented, as they may be found useful.

SEA SALT OF WOODS HOLE.

	Percentage.	
	No. 1	No. 2.
Sodium.....	30.68	30.49
Magnesium.....	3.31	3.48
Calcium.....	1.27	1.12
Silica.....	0.014	0.018
Phosphate.....	Trace	Trace
Nitrate.....	Trace	Trace

The above analyses would tend to confirm the suggestion made in our former paper that the Kramer-Gittleman direct method for the determination of sodium, while very convenient for relative data, may give an absolute value which is low. One must remember, however, that using the Haywood and Smith Method

(7) or that of Dittmar the sodium determination comes out low, as has been the universal experience of analysts. The values are then corrected by employing Dittmar's method (2) of "total sulphates." The older methods for sodium determinations are so cumbersome (as reference to Dittmar's article will show) that there is still some doubt as to the accuracy of the results.

During the Summer of 1928 we have again confirmed Atkins' (8) and Harvey's (9) work on the nitrates and phosphates. Samples of the Woods Hole water showed only the smallest trace of NO_3 and PO_4 during July 1928, the time at which our analyses were made this year. This change is, as they have shown, due to seasonal variations in the plankton.

SUMMARY.

1. The chlorine content of Woods Hole sea water has been examined over a three-week period and shown not to vary within any large range.
2. Analyses of the sea salt are presented.

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